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(54) EXPANDABLE FASTENER

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EXPANDABLE FASTENER

(Abstract)

An expandable fastener is disclosed having an elongated body which is square in cross-section and provided with a longitudinally extending slot bisecting opposed corners of the body to define a pair of legs each triangular in cross-section. The body is longitudinally apertured to receive a circular pin by which the legs are displaced for the radially opposite corner edges thereof to move radially outwardly in a plane extending through the pin axis and bisecting the corners of the legs.

(Disclosure)

The present invention relates to the art of expandable fasteners and, more particularly, to an improved expandable fastener of polygonal cross-section.

Expandable fasteners having a polygonal cross-section have been provided heretofore. Such fasteners, for example, include a body of malleable metal or plastic having a plurality of longitudinally extending legs defined by one or more slots extending longitudinally of the body. Further, such fasteners generally are provided with an axially central passageway to receive a wedging member such as a pin by which the legs are displaced laterally of the pin axis. Such polygonal fasteners are generally inserted into an opening of corresponding polygonal configuration in a component with which the fastener is to be interengaged, and the pin is axially driven into the fastener to displace the legs laterally of the pin axis and into wedging engagement with the walls of the polygonal opening.

A number of polygonal fastener structures of the foregoing character are shown in British Patent 335,508.

In polygonal expandable fasteners heretofore provided, including those shown in the aforementioned British patent, each leg of the fastener includes a generally planar outer surface which faces a corresponding surface of the opening into which the fastener is inserted. Upon displacement of the pin into the fastener, such leg surfaces are displaced outwardly perpendicular to the plane thereof into facial engagement with the corresponding opening surface. Such displacement of the outer surface of the leg is the result of the direction of the application of force on the leg by the wedging member or pin. In the event of inaccuracies between the contour of the opening and the fastener received therein, such facial engagement can result in lateral slippage between the leg faces and fastener walls in the planes of engagement therebetween. Such slippage produces wear of the engaging surfaces and progressively reduces the frictional retention force between the fastener and opening. Moreover, inaccuracies between the contour of the opening and fastener received therein can result in unequal frictional engagement between different ones of the outer surfaces of the fastener legs and the corresponding surfaces of the opening. Ideally, all of the leg surfaces are pressed against the corresponding opening surfaces with equal force to maximize the retention capability for a given fastener. Therefore, it will be appreciated that the existence of less than maximum frictional interengagement between one leg surface and the corresponding opening surface reduces the retention capability. Still further, inaccuracies in the opening contour and fastener contour can result in other than true planar

engagement between the outer surface of a leg and a corresponding surface of an opening, and this relationship too reduces the fastener retention capability.

In accordance with the present invention, an expandable fastener of polygonal cross-section is provided by which improved surfaced interengagement and fastener retention are achieved. In this respect, the polygonal expandable fastener according to the present invention includes at least two legs each having generally planar outer surfaces intersecting along a longitudinal edge spaced from the fastener axis. The legs are displaced radially of the fastener axis by the wedging member such that the force of displacement acts through the edge between the outer surfaces of the legs. Accordingly, the corner between the outer surfaces of the legs is displaced into the corner between the corresponding surfaces of the opening into which the fastener is inserted. This corner-to-corner relationship improves facial engagement of the outer surfaces of the legs with the corresponding planar surfaces of the opening and eliminates relative lateral movement between the leg surfaces and opening surfaces in the planes of engagement therebetween. Further, the application of retention force through the corner between the outer surfaces of the legs assures a more uniform application of retention force laterally between the fastener legs and opening in the event of inaccuracies in the contours of the fastener and opening.

In accordance with a preferred embodiment of the invention, an expandable fastener assembly comprises a cast plug of malleable metal including an elongate body portion having an axis and opposite ends and a head at one of said ends, said body being square in cross section along the length thereof from said head to the other of said opposite ends and

having opposed pairs of parallel sides between said ends, said head extending radially outwardly from said sides, said body including a single slot of uniform width extending longitudinally from the other of said ends of said body toward said head and terminating in said body at a location closely spaced from said head in the direction toward said other end, said slot being disposed diagonally with respect to said sides and dividing the corresponding longitudinal portion of said body into a pair of identical triangular legs symmetric with respect to said axis and having opposed parallel inner faces along the length of said slot, said legs having outer corners including parallel longitudinally extending outer edges defined by the intersection of corresponding ones of said sides of said body, a plane through said body axis and both said outer edges bisecting said outer corners and being perpendicular to the planes of said opposed inner faces of said legs, said cast plug including a circular pin receiving passage coaxial with said body axis and extending through said head into said body and opening into said slot at said location, said opposed inner faces of said legs including opposed identical recesses extending longitudinally from said location to said other end of said body, each said recess being arcuate in cross section and laterally symmetrical with respect to said plane bisecting said corners, said recesses tapering uniformly and radially inwardly in the direction from said location toward said other end, said recesses together having a diameter at said location whereby said taper provides for corresponding portions of the lengths of said recesses from said location toward said other end to be spaced apart a distance less than said diameter, and a circular metal pin axially slidably receivable in said passageway and in said opposed recesses for diametrically opposite sides of said pin to engage said recesses and displace said outer edges of said

legs radially outwardly of said body axis in said plane bisecting said corners of said legs, said pin being of uniform diameter throughout the length thereof, said pin diameter being slightly greater than said diameter of said recesses at said location to provide a tight fit therebetween, and said recesses at said other end of said body being longitudinally open to permit axial displacement of said pin through said body in the direction toward said other end for removal of said pin from said plug.

In accordance with a further embodiment of the invention, an expandable fastener assembly comprises a cast plug of malleable metal including an elongate body portion having an axis and opposite ends and a head at one of said ends, said body being square in cross section along the length thereof from said head to the other of said opposite ends and having opposed pairs of parallel sides between said ends, said head extending radially outwardly from said sides, said body including a single slot of uniform width extending longitudinally from the other of said ends of said body toward said head and terminating in said body at a location closely spaced from said head in the direction toward said other end, said slot being disposed diagonally with respect to said sides and dividing the corresponding longitudinal portion of said body into a pair of identical triangular legs symmetric with respect to said axis and having opposed parallel inner faces along the length of said slot, each said legs being of solid cross section and having like cross sectional dimensions along the lengths thereof, said legs having outer corners including parallel longitudinally extending outer edges defined by the intersection of corresponding ones of said sides of said body, a plane through said body axis and both said outer edges bisecting said outer corners and being perpendicular to the

planes of said opposed inner faces of said legs, said cast plug including a circular pin receiving passage coaxial with said body axis and extending through said head into said body and opening into said slot at said location, said opposed inner faces of said legs including opposed identical recesses extending longitudinally from said location to said other end of said body, each said recess being circular in cross section and laterally symmetrical with respect to said plane bisecting said corners, said recesses tapering uniformly and radially inwardly in the direction from said location toward said other end, said pin receiving passage being of uniform diameter along the length thereof, said recesses together having said diameter at said location, whereby said recess taper provides for corresponding portions of the lengths of said recesses from said location toward said other end to be spaced apart a distance less than said diameter, and a circular metal pin axially slidably receivable in said passageway and in said opposed recesses for diametrically opposite sides of said pin to engage said recesses and displace said outer edges of said legs radially outwardly of said body axis in said plane bisecting said corners of said legs, said pins being of uniform diameter throughout the length thereof, said pin diameter being slightly greater than said diameter of said pin receiving passageway to provide a tight fit therebetween, and said recesses at said other end of said body being longitudinally open to permit axial displacement of said pin through said body in the direction toward said other end for removal of said pin from said plug.

The foregoing aspects, and others, will be pointed out more fully hereinafter in conjunction with the written description of a preferred embodiment shown in the accompanying drawings in which:

FIGURE 1 is a side view of the body and pin components of an expandable fastener according to the present invention and showing the fastener body in assembled relationship with structural members to be joined;

FIGURE 2 is a plan view of the fastener body looking in the direction of line 2-2 in FIGURE 1;

FIGURE 3 is a cross-sectional view of the fastener body taken along line 3-3 in FIGURE 1;

FIGURE 4 is a sectional elevation view of the fastener body taken along line 4-4 in FIGURE 3; and,

FIGURE 5 is a diagrammatic illustration in cross-section of the interengaging relationship between the legs of the

fastener and an opening in a structural member receiving the fastener.

Referring now in greater detail to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting the invention, the fastener shown includes a cast plug of malleable metal, such as aluminum, having an elongate body portion 10 which is square in cross-section and has a central longitudinal axis 12. Body 10 includes longitudinally extending generally planar outer surfaces 14, 16, 18 and 20. The planes of outer surfaces 14 and 16 are at right angles to one another and intersect in a longitudinal edge 22, and the planes of outer surfaces 18 and 20 are at right angles to one another and intersect in a longitudinal edge 24. Likewise, the planes of outer surfaces 16 and 18 intersect along a longitudinal edge 26, and the planes of outer surfaces 14 and 20 intersect along a longitudinal edge 28. A head 30 is provided at one end of body 10 and preferably, though not necessarily, is square in cross-sectional configuration and includes portions extending radially outwardly from a corresponding one of the outer surfaces 14, 16, 18 and 20.

Body 10 is provided with a longitudinally extending slot 32 which opens radially through the body and diagonally between longitudinal edges 26 and 28 thereof. The plane of slot 32, represented by the numeral 34 in FIGURE 3, intersects fastener axis 12 and edges 26 and 28 of the body. Further, a

plane through fastener axis 12 and longitudinal edges 22 and 24 of body 10, represented by numeral 36 in FIGURE 3, is perpendicular to plane 34 and bisects the angle between outer surfaces 14 and 16 and the angle between outer surfaces 18 and 20.

Slot 32 opens longitudinally into body 10 from the end thereof spaced from head 30 and has an inner end 38 axially spaced from inner face 30a of head 30 to provide the body with a shank portion 40 which serves the purpose set forth hereinafter. Slot 32 has opposed parallel walls 42 and 44 and divides the corresponding axial portion of body 10 into a pair of legs each trangular in cross-sectional configuration. More particularly, one of the legs is defined by outer surfaces 14 and 16 and slot wall 42, and the other leg is defined by outer surfaces 18 and 20 and slot wall 44. Each leg is of course integral with shank portion 40 at the corresponding end of body 10.

Body 10 is provided with a circular passageway extending axially therethrough and including a first portion 46 and a second portion 48. Portion 46 of the passageway is of uniform diameter and extends through head 30 from the outer end thereof to inner end 38 of slot 32. Second portion 48 of the passageway extends from end 38 of slot 32 through the opposite end of body 10 and tapers axially and radially inwardly between slot end 38 and the outer end of body 10. Preferably, the end of passage portion 48 at inner end 38 of slot 32 corresponds in diameter to passage portion 46 and converges uniformly to a smaller diameter at the outer end of body 10. Preferably, slot 32 has a width between walls 42 and 44 thereof less than the diameter of passage portion 48 at the outer end of body 10. Accordingly, walls 42 and 44 intersect passageway portion 48 along the length thereof to define arcuate recesses 48a each of which

tapers in the direction from end 38 of slot 22 to the outer end of body 10. Each of the recesses 48a defines a force receiving surface for the corresponding triangular leg, and each of the recesses 48a is laterally symmetric with respect to plane 36.

A cylindrical pin 50 of steel or the like is adapted to be received in passageway portion 46 and displaced axially into passageway portion 48 to radially displace the fastener legs. Preferably, pin 50 has a diameter providing a tight fit with cylindrical passage portion 46 so as to require an impact force such as by the use of a hammer to displace the pin into body 10. It will be appreciated that the uniform diameter of pin 50 and the tapering configuration of passageway portion 48 provides for diametrically opposed surface portions of pin 50 to engage recesses 48a and radially displace the triangular legs outwardly with respect to fastener axis 12. Cylindrical portion 46 of the passageway guides axial displacement of pin 50 relative to body 10, and it will be appreciated from FIGURE 1 that the symmetrical relationship of recesses 48a with respect to plane 36 provides for the radial expanding force of pin 50 on the triangular legs to be directed in opposite directions in plane 36 from axis 12 and through edges 22 and 24 of the legs.

The fastener described hereinabove can be employed, for example, to interconnect a plate component 52 with the end of a tubular member 54, which components are shown schematically in FIGURE 1, and the interengaging relationship between the legs of the fastener and such a tubular member is illustrated in FIGURE 5. Referring to these Figures, tubular member 54 is shown as a square tube having a square opening 56 which receives body portion 10 of the fastener. Generally, opening 56 will

correspond in cross-sectional contour and dimension with that of body 10 prior to radial expansion of the fastener legs. In FIGURE 5 an exaggerated clearance space is shown between the outer surfaces of the legs of the fastener and the inner surfaces of opening 56 in member 54 to facilitate a better showing of the action which takes place upon radial expansion of the legs.

As shown schematically in FIGURE 1, plate member 52 has an opening 58 adapted to receive the fastener body such that inner face 30a of head 30 engages the outer surface of plate 52. Preferably, opening 58 is square and conforms in cross-sectional configuration and dimension with shank portion 40. Generally, in an assembly such as that illustrated, shank portion 40 will have an axial extent corresponding to the thickness of plate member 52. Preferably shank portion 40 is provided with a plurality of longitudinally extending radially outwardly projecting ribs 40a adapted to engage the sides of opening 58 upon insertion of the fastener thereinto to facilitate retention of the fastener relative to plate 52 to eliminate any lateral free play which might exist between the fastener and opening. Opening 56 in tubular member 54 provides opposed pairs of parallel spaced apart wall surfaces each parallel to a corresponding one of the fastener surfaces 14, 16, 18 and 20. Further, the wall surfaces of opening 56 intersect to define a corner 60 facing edge 22 of the fastener body and a corner 62 facing edge 24 of the fastener body.

When the fastener body is initially inserted into opening 56, surfaces 14, 16, 18 and 20 thereof are in the solid line positions shown in FIGURE 5 with respect to the inner walls of opening 56. As pin 50 is driven axially into body 10 and

progressively from passageway portion 46 into passageway portion 48, the outer surface of the pin engages recesses 48a displacing edges 22 and 24 in the directions of arrows 64 and 66, respectively, in the manner described hereinabove. Such displacement moves the legs of the fastener into the broken line positions illustrated in FIGURE 5 and in which edge 22 is displaced toward corner 60 of opening 56 and edge 24 is displaced toward corner 62 of the opening. When the pin is fully seated in the fastener body, edges 22 and 24 are disposed in the respective corner of opening 56 and outer surfaces 14 and 16 of the one leg and outer surfaces 18 and 20 of the other leg facially engage the corresponding walls of opening 56. The force of engagement as described hereinabove is through fastener edges 22 and 24 to maximize fastener retention in opening 56. Preferably, outer surfaces 14, 16, 18 and 20 of body 10 are provided with axially spaced apart parallel ribs 14a, 16a, 18a and 20a, which ribs are axially narrow and have relatively sharp outer edges adapted to bite into the material of the inner walls of opening 56 to further facilitate fastener retention with respect to member 54.

In the use of the fastener, especially with a tubular member such as member 54, the application of force in diametrically opposite directions relative to pin 50 and through edges 22 and 24 of the fastener legs tends to distend the corresponding corners of the fastener receiving opening radially outwardly relative to the axis of the fastener and to constrict the other corners of the opening radially inwardly of the fastener axis. Such distending and constricting action further increases the retentive interengagement between the fastener legs and inner walls of the fastener receiving opening. In any event,

it will be appreciated that displacement of fastener edges 22 and 24 into the corresponding corners of the fastener receiving opening under the wedging action of pin 50 prevents any relative lateral displacement between surfaces 14, 16, 18 and 20 and the corresponding walls of the opening in the planes of engagement therebetween.

While considerable emphasis has been placed herein on the preferred square cross-sectional configuration of the fastener and the single diagonal slot thereacross providing triangular shaped legs by which the desired application of radial expanding force is transmitted through outer corners of the legs, it will be appreciated that other polygonal configurations can be employed for the legs without departing from the principles of the present invention. In accordance with the present invention, it is only necessary to provide for each leg to have a pair of generally planar outer surfaces intersecting along a longitudinal line and defining an angle therebetween which is bisected by a plane extending through the line and the fastener axis, and to provide the legs with force receiving inner surface portions laterally symmetric with respect to the bisecting plane so that the wedging member applies a force to the leg which is transmitted in the bisecting plane to displace the leg edge radially outwardly in the latter plane. Many structural configurations can be devised for achieving the desired end result, the specific arrangement herein illustrated and described being the preferred arrangement. Moreover, it will be appreciated that spreading of the legs can be achieved other than by a tapered recess and cylindrical pin and that many structural arrangements for achieving expansion of the fastener can be devised and employed without

departing from the principles of the present invention.

As many possible embodiments of the present invention may be made and as many possible changes can be made in the embodiment herein illustrated and described, it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the present invention and not as a limitation.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An expandable fastener assembly comprising a cast plug of malleable metal including an elongate body portion having an axis and opposite ends and a head at one of said ends, said body being square in cross section along the length thereof from said head to the other of said opposite ends and having opposed pairs of parallel sides between said ends, said head extending radially outwardly from said sides, said body including a single slot of uniform width extending longitudinally from the other of said ends of said body toward said head and terminating in said body at a location closely spaced from said head in the direction toward said other end, said slot being disposed diagonally with respect to said sides and dividing the corresponding longitudinal portion of said body into a pair of identical triangular legs symmetric with respect to said axis and having opposed parallel inner faces along the length of said slot, said legs having outer corners including parallel longitudinally extending outer edges defined by the intersection of corresponding ones of said sides of said body, a plane through said body axis and both said outer edges bisecting said outer corners and being perpendicular to the planes of said opposed inner faces of said legs, said cast plug including a circular pin receiving passage coaxial with said body axis and extending through said head into said body and opening into said slot at said location, said opposed inner faces of said legs including opposed identical recesses extending longitudinally from said location to said other end of said body, each said recess being arcuate in cross section and laterally symmetrical with respect to said plane bisecting said corners, said recesses tapering uniformly

and radially inwardly in the direction from said location toward said other end, said recesses together having a diameter at said location whereby said taper provides for corresponding portions of the lengths of said recesses from said location toward said other end to be spaced apart a distance less than said diameter, and a circular metal pin axially slidably receivable in said passageway and in said opposed recesses for diametrically opposite sides of said pin to engage said recesses and displace said outer edges of said legs radially outwardly of said body axis in said plane bisecting said corners of said legs, said pin being of uniform diameter throughout the length thereof, said pin diameter being slightly greater than said said diameter of said recesses at said location to provide a tight fit therebetween, and said recesses at said other end of said body being longitudinally open to permit axial displacement of said pin through said body in the direction toward said other end for removal of said pin from said plug.

2. The fastener assembly according to claim 1, and longitudinally spaced apart laterally extending ribs projecting outwardly from each of said sides of said body between said location and said other end.

3. The fastener assembly according to claim 2, and longitudinally extending radially outwardly projecting ribs on said sides of said body between said head and said location.

4. An expandable fastener assembly comprising a cast plug of malleable metal including an elongate body portion having an axis and opposite ends and a head at one of said ends, said body being square in cross section along the length thereof from said head to the other of said opposite

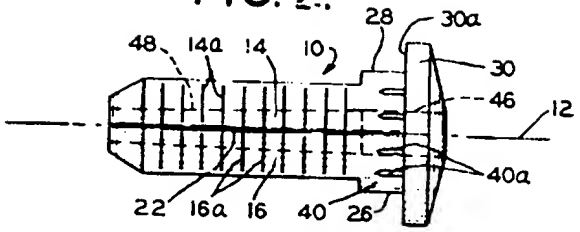
ends and having opposed pairs of parallel sides between said ends, said head extending radially outwardly from said sides, said body including a single slot of uniform width extending longitudinally from the other of said ends of said body toward said head and terminating in said body at a location closely spaced from said head in the direction toward said other end, said slot being disposed diagonally with respect to said sides and dividing the corresponding longitudinal portion of said body into a pair of identical triangular legs symmetric with respect to said axis and having opposed parallel inner faces along the length of said slot, each said legs being of solid cross section and having like cross sectional dimensions along the lengths thereof, said legs having outer corners including parallel longitudinally extending outer edges defined by the intersection of corresponding ones of said sides of said body, a plane through said body axis and both said outer edges bisecting said outer corners and being perpendicular to the planes of said opposed inner faces of said legs, said cast plug including a circular pin receiving passage coaxial with said body axis and extending through said head into said body and opening into said slot at said location, said opposed inner faces of said legs including opposed identical recesses extending longitudinally from said location to said other end of said body, each said recess being circular in cross section and laterally symmetrical with respect to said plane bisecting said corners, said recesses tapering uniformly and radially inwardly in the direction from said location toward said other end, said pin receiving passage being of uniform diameter along the length thereof, said recesses together having said diameter at said location, whereby said recess

taper provides for corresponding portions of the lengths of said recesses from said location toward said other end to be spaced apart a distance less than said diameter, and a circular metal pin axially slidably receivable in said passageway and in said opposed recesses for diametrically opposite sides of said pin to engage said recesses and displace said outer edges of said legs radially outwardly of said body axis in said plane bisecting said corners of said legs, said pins being of uniform diameter throughout the length thereof, said pin diameter being slightly greater than said diameter of said pin receiving passageway to provide a tight fit therebetween, and said recesses at said other end of said body being longitudinally open to permit axial displacement of said pin through said body in the direction toward said other end for removal of said pin from said plug.

5. The fastener assembly according to claim 4, and longitudinally spaced apart laterally extending ribs projecting outwardly from each of said sides of said body between said location and said other end.

6. The fastener assembly according to claim 5, nd longitudinally extending radially outwardly projecting ribs n said sides of said body between said head and said location.

FIG. 2.



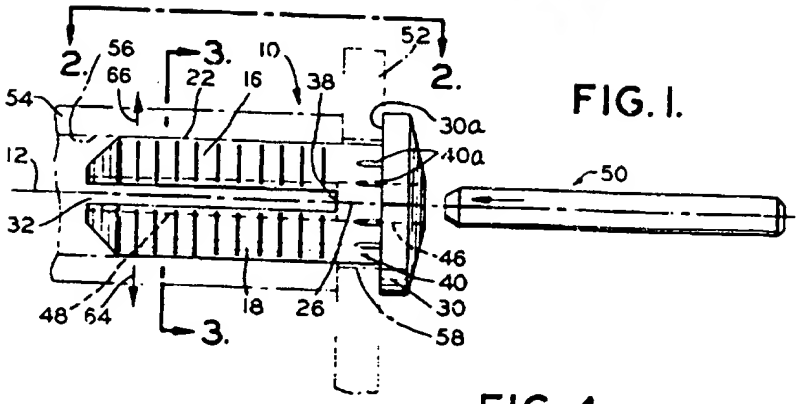


FIG. 1.

FIG. 4.

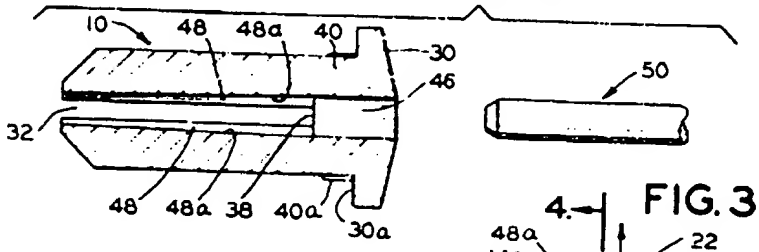


FIG. 5.

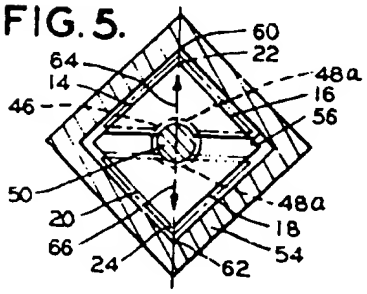


FIG. 3.